MISCONCEPTION PROFILE ON PHOTOSYNTHESIS BY USING FOUR-TIER DIAGNOSTIC TEST ON TWELVE GRADE STUDENTS OF SENIOR HIGH SCHOOL

Profil Miskonsepsi Pada Submateri Fotosintesis Menggunakan Four-tier Diagnostic Test Pada Siswa Kelas XII SMA

Nadya Eka Aristyasari

Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
E-mail: nadya.17030204044@mhs.unesa.ac.id

Yuliani

Biology Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
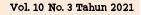E-mail: yuliani@unesa.ac.id

Abstract

Misconception is a concept that is incompatible with scientific understanding or with experts in the field. If misconceptions are not immediately resolved, they will continue to be stored in the students' memory, it will have a negative impact on concept acceptance and understanding of the next material because concepts in biology are interrelated. Photosynthetic sub-material is one of the materials in Biology where misconceptions are often found. This concept is a complex and abstract so that students have difficulty to understanding it. The purpose of this research is to describe the profile of students' misconceptions in the photosynthesis submission by using four-tier diagnostic test. This research is a descriptive evaluative research, was make four-tier diagnostic test instrument that is validated by two expert, testing questions, analyzing the results of the research by using category tables and criteria for the level of misconceptions, and make a conclusions. The subjects in this study were 60 students of class XII who had received photosynthesis material. The data obtained were analyzed using a table of students' conception criteria based on four-tier test. The results showed that the profile of students' misconceptions consisted of students who experienced misconceptions which was 45.5%, students who understood the concept was 28%, and students who did not understand the concepts was 26.5%. The criteria for the level of misconception among students were high misconception was 46.7%, moderate misconception was 29.8%, and low misconception was 23.5%.

Keywords: profile, misconception, photosynthesis, four-tier diagnostic test.

Abstrak

Miskonsepsi merupakan suatu konsep yang tidak sesuai dengan pengertian ilmiah atau dengan ahli atau pakar dalam bidang tersebut. Apabila miskonsepsi tidak segera diatasi maka dan terus disimpan dalam memori siswa, maka akan berdampak negatif pada penerimaan dan pemahaman konsep pada materi selanjutnya karena konsep – konsep dalam biologi saling berkaitan. Submateri fotosintesis merupakan salah satu materi dalam pembelajaran Biologi yang sering ditemukan adanya miskonsepsi. Konsep ini merupakan konsep yang kompleks dan abstrak sehingga siswa mengalami kesulitan dalam memahaminya. Tujuan dari penelitian ini adalah mendeskripsikan profil miskonsepsi siswa pada submateri fotosintesis menggunakan four-tier diagnostic test. Penelitian ini merupakan penelitian deskriptif evaluatif, yaitu membuat instrumen tes four-tier diagnostic test yang divalidasi oleh ahli, mengujikan soal, analisis hasil penelitian dengan menggunakan tabel kategori dan kriteria tingkat miskonsepsi, serta menarik kesimpulan. Subjek dalam penelitian ini adalah siswa kelas XII yang berjumlah 60 siswa yang telah mendapatkan materi fotosintesis. Data yang diperoleh dianalisis menggunakan tabel kriteria konsepsi siswa berdasarkan four-tier test. Hasil penelitian menunjukkan profil miskonsepsi siswa terdiri atas siswa yang mengalami miskonsepsi sebesar 45,5%, siswa paham konsep sebesar 28%, dan siswa yang belum paham konsep sebesar 26,5%. Didapatkan kriteria tingkat miskonsepsi pada siswa yaitu miskonsepsi tinggi sebesar 46,7%, miskonsepsi sedang sebesar 29,8%, dan miskonsepsi rendah sebesar 23,5%.

Kata Kunci*: profil, miskonsepsi, fotosintesis, four-tier diagnostic test.*

INTRODUCTION

It is necessary to comprehend basic concepts in understanding a concept. Concepts in biology studies have correlation and related each other. Biology itself is a lesson where students got a lot of difficulty in understanding the concepts given by the teacher. This is because there are many abstract concepts in biology and can make it difficult for students to build up their knowledge (Ibrahim, 2012).

Preconceptions are built by the students themselves, in science learning activities, students come with the initial preconceptions that were previously obtained and will be reformed through physical and social interactions in the classroom as a result of learning (Setiawati et al., 2014). The development of an understanding of the learner's concept occurs before and during the students studying in school. Teacher explanations and textbooks can make this understanding better. However, what might happen is that the explanation that students receive from both the teacher and the textbook is inconsistent with scientific concepts or it can be stated that students have misconceptions (Blosser, 1987). Misconception is the difference between students' understanding of concepts and the scientific concepts they receive.

Misconception is more than a misunderstanding of a concept or it can be said as a part of a larger knowledge system that includes a number of interrelated concepts that learners use to understand their experiences. Misconceptions are caused by three factors, it because of the learning resources used, wrong understanding during learning, wrong teachers explanation and inaccuracy during the teaching and learning process (Pabucu, 2004).

Photosynthesis is one of the submaterials contained in anabolic material, where the anabolic material discusses the photosynthetic process and the chemosynthetic process. There is a research stated that the concept of photosynthesis is a concept which is difficult for biology education students to understand because there are many abstract concepts in it and also require a lot of long and complicated chemical reactions (Susanti, et al. 2010).

Based on the study of data on the results of the National Examination for the 2018/2019 academic year, it is found that students' completeness on metabolic material only 39.70%. This proves that most of the students have not yet completed the indicators of cell metabolism material which discusses the material of photosynthesis and plant respiration.

Research conducted by Machsunah (2019) states that the material of photosynthesis and plant respiration in class XII is difficult material for students to understand, therefore most teachers find it difficult to teach this material so that student misconceptions often occur, one of the example is the concept of the general mechanism of photosynthesis. According to Kribulut and Omer (2014), an assessment tool used to identify misconceptions experienced by students is through interviews, concept maps, and multiple choice tests. In addition, diagnostic tools are also used which are expected to be able to detect a lack of knowledge, such as the four-tier diagnostic test. The four-tier diagnostic test instrument consists of four levels, the first level contains the answer choices, the second level is the confidence level, then the third level is the choice of reasons, and at the fourth level there is a level of confidence in the third level answers.

The advantages of the choice with four level diagnostic test make the teacher can: (1) find out the understanding and mastery of concepts that students have through differences in the level of confidence in the answers and the level of confidence in students' reasons, (2) be more detailed in diagnosing students who experience misconceptions, (3) knowing where the emphasis is on parts of the material that are felt to have many misconceptions, (4) do better lesson planning to be able to reduce and overcome misconceptions experienced by students. Therefore, it is necessary to conduct a study that aims to describe the profile of students' misconceptions in the photosynthesis submission using a four-tier diagnostic test.

METHOD

This research is a descriptive evaluative study by the collecting data and then comparing it with predetermined criteria. The data obtained are analyzed to obtain the results in the form of students' misconception profiles, quantitative data obtained in the form of the percentage of students who had misconceptions, who

belong the student that understood the concept and who did not understand the concept, and then it will be concluded.

This research is divided into three stages, first the preparation stage, then implementation stage, and the last is completion stage. The preparation stage is the first stage that the manufacture of a four tier diagnostic test instrument which is then validated by the validator lecturer which includes material, construction, and language. The second stage is the implementation stage, namely the data collection process by means of students doing the four tier diagnostic test questions. The third stage is the stage of completion, namely the stage of data analysis and drawing conclusions.

This research was conducted in December 2020 - January 2021 with the research target of 60 students from class XII MIPA 3 and XII MIPA 4 Senior High School 1 Tarik. The instrument of this study used four-tier diagnostic test instrument for photosynthetic submaterial. The data analysis technique uses the student conceptual category table in table 1 below.

Table 1.Categories of Student Conception

Phase				Criteria
I	II	III	IV	
Correct	Sure	Correct	Sure	Understand
Correct	Sure	Correct	Not sure	Not understand
Correct	Not sure	Correct	Sure	Not understand
Correct	Not sure	Correct	Not sure	Not understand
Correct	Sure	Wrong	Sure	Misconception
Correct	Sure	Wrong	Not sure	Not understand
Correct	Not sure	Wrong	Sure	Not understand
Correct	Not sure	Wrong	Not sure	Not understand
Wrong	Sure	Correct	Sure	Not understand
Wrong	Sure	Correct	Not sure	Not understand
Wrong	Not sure	Correct	Sure	Not understand
Wrong	Not sure	Correct	Not sure	Not understand
Wrong	Sure	Wrong	Sure	Misconception
Wrong	Sure	Wrong	Not sure	Not understand

Phase				Criteria
I	II	III	IV	
Wrong	Not sure	Wrong	Sure	Not understand
Wrong	Not sure	Wrong	Not sure	Not understand

Source: Gurel et al. (2015)

The percentage for each category of students' conceptual comprehension can be obtained using the following formula.

$$P = \frac{f}{N} \ x \ 100\%$$

Description:
P = Percentage of conceptual comprehension
F = Students' number in each category
N = Total students' number

The percentage of student misconceptions obtained is categorized into three criteria, namely, low misconceptions if the percentage is 0% - 30%, moderate misconception if the percentage is 31% - 60% and high misconceptions if the percentage is 61% - 100% (Arikunto, 2013).
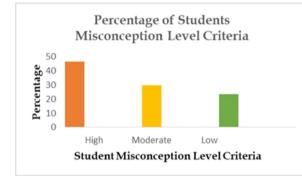
RESULT AND DISCUSSION

This study produces data in the form of the percentage of student misconceptions. In this study, the students' misconception profiles are in the form of students' conceptions, the level of students' misconceptions, and the concepts that become misconceptions. Based on the test results given to students, it can be seen that the percentage of students' conception categories on the concepts contained in the photosynthesis submaterial is presented in Picture 1 below.

Picture 1. Total Average Percentage of Students' Conception

Based on Picture 1. above, it can be known in the percentage of student conceptions, students who experience misconceptions as much as 45.5%, as many as 28% of students understand the concept, and 26.5% of students do not understand the concept. The results also showed that there was a level of student misconception that was grouped into three categories, namely low misconception, moderate misconception, and high misconception. The level of student misconceptions and the average percentage of the criteria is presented in the following diagram (Picture 2.).

Picture 2. Criteria Diagram for the Level of Student Misconceptions

Based on Picture 2. above, it can be known that the percentage of student misconception level criteria of low misconception is 23.5%, moderate misconception is 29.8%, and high misconception is 46.7%. The results also showed that there were students conceptions on each item in order to know the level of misconceptions in each indicator and the concept of photosynthetic sub-material. The level of students' conception on each item can be seen in table 2. below.

Concept	Indicator	Number	M (%)	U (%)	N (%)
Photosynthetic components	Describe the components involved in photosynthesis	1	30	60	10
General mechanism of photosynthesis	Describe the general mechanism of photosynthesis	2	53,33	26,67	20
General mechanism of photosynthesis	Identify energy sources in the photosynthesis	3	25	63,33	11,67
		4	40	46,67	13,33

Concept	Indicator	Number	M (%)	U (%)	N (%)
The place where photosynthesis take place	Shows the processes that occur in the structure of chloroplast	5	45	16,67	38,33
	Determine the function of chlorophyll and photosynthetic pigments in the photosystem structure	6	61,66	16,67	21,67
Photosynthetic components	Identify the types of enzymes that play a role in C3, C4, and CAM plants	7	51,67	15	33,33
	Determine the size of the capture centre in photosystem I and photosystem II	8	41,67	26,66	31,67
	Analyze the photosynthetic absorption spectrum based on graphical analysis which is effective in the process	9	43,33	30	26,67
	Analyze the effect of light on the photosynthesis process based on the experimental result	10	48,33	31,67	20
		11	26,67	43,33	30
Light and dark reaction	Analyze the type and timing of photosynthetic based on molecular change	12	48,33	20	31,67
Photophosphorylation	Determine the mechanism of the photophorylation process	13	53,33	16,67	30

Concept	Indicator	Number	M (%)	U (%)	N (%)
Photophos-phorylation	Identify the type and process of photophos-phorylation in the light reaction	14	45	18,33	36,67
		15	50	16,67	33,33
Light and dark reaction	Analyze the type and timing of photosynthetic reactions based on molecular changes	16	55	28,33	16,67
	Determine the product of the light reaction process and the dark reaction	17	53,33	25	21,67
	Analyze the phases in the Calvin cycle process based on the processes that occur	18	43,33	20	36,67
		19	45	21,67	33,33
CO2 conversion pathway (C3, C4, and CAM plants)	Distinguish the molecular changes in the carbon reaction pathway	20	48,34	18,33	33,3

Note :

M   : Misconception

U   : Understand the concept

N   : Not understand the concept

Based on table 4.2 above, it can be seen the percentage of misconceptions on each item which indicates a misconception in each concept in the photosynthetic submaterial. Based on the result obtained the highest misconception category was found in the indicator determining the function of chlorophyll and photosynthetic pigments in the photosystem structure as 61.66%.

The results of the research conducted in class XII MIPA 3 and XII MIPA 4 SMA Negeri 1 Tarik

showed that the students' conception profiles were 45.5% of students who had misconceptions, 28% of students understood concepts, and 26.5% of students did not understand concepts. There is a level of student conception (conceptual understanding, misconception, not understanding the concept) because students have different cognitive abilities towards a concept they are learning (Suparno, 2005).

Students who have a conceptual understanding category have higher knowledge than students who have other conceptual categories. Students who understand the concept have criteria, that is students answer correctly at tier 1 and tier 3 and are confident in their choice or choose to believe in tier 2 and tier 4. Students who have a concept understanding category can say that they can build an understanding between the newly accepted concept and the others concepts that have been previously owned and able to explain it correctly (Iriyanti et al, 2017). Students who understand the concept can be said that students can re-express the concept in another form so that its meaning can be easily understood without changing the meaning scientifically, which means that students do not just memorize the concept (Tapilouw & Setiawan, 2008).

Students who fall into the category of not understanding the concept are students who are not sure of the answers they have chosen or choose a level of confidence that is unsure of either tier 2 or tier 4 or both (Gurel et.al, 2015). The percentage of students who did not understand the concept was not higher than students who understood the concept is 26.5%. Students who do not understand the concept of choosing answers and reasons are likely to just guess. This is due to the insufficient information obtained by students in building their knowledge of a concept (Pesman & Eryilmas, 2010). The incomplete understanding of students towards a concept is due to the students' weak understanding of previously learned concepts, which can lead to misconceptions (Fitriana, 2012). Students who do not understand the concept do not understand the concept because most of them have difficulty learning the concepts that exist in the photosynthesis sub-material because the concept is complex and abstract enough so that students have difficulty learning it (Wahyuni, 2013).

The percentage of misconception that occurs in students higher than percentage of students who

understand the concept and do not understand the concept that is 45.5%. Students who experience misconceptions can be known from their choice of answers by answering incorrectly on tier 1 and tier 3 or on the choice of answers and reasons and being sure of their choice (Gurel et.al, 2015). Misconceptions in students still occur even though students have obtained the concepts of photosynthetic sub-materials. This shows that misconceptions are resistant and tend to persist and are difficult to change (Ibrahim, 2012). When students' memory or retention of the concepts they have learned is reduced, misconceptions can easily occur again in students. Students' understanding is low and changes easily due to the lack of repetition of material which is considered difficult, which causes a decrease in students' memory (Nusantari, 2015).

The percentage of students' misconceptions was included in three categories, they are low misconception is 23.5%, moderate misconception is 29.8%, and high misconception is 46.7%. The level of misconception exists because students have different cognitive abilities, students who experience high misconceptions have lower cognitive abilities than students who belong to the moderate and low misconception categories (Luciana, 2017). Learning interest is very influential on the level of student misconceptions, high misconceptions indicate that students have low interest in learning (Asnunsa, 2016). Student retention also affects students' conceptual understanding, students who have high retention power are less likely to experience misconceptions because students can easily remember and understand the concepts they have learned so that concepts are not easily changed or wrong when the concept is needed (Hasanah et al, 2017) .

The results showed that students have a misconceptions experience at all concepts and it was known that the highest misconceptions were in the concepts related to the function of chlorophyll and photosynthetic pigments, that is 61.66% and the concept of type and reaction time in the photo- synthesis process by 55%. In the concept of the function of chlorophyll in the photosystem structure, the percentage of students who experienced misconceptions is 61.66%. Most of the students assumed that chlorophyll functions in breaking down light so that it is evenly distributed in the chloroplast structure. The correct concept is that chlorophyll functions to absorb light in the form of electromagnetic radiation in the visible spectrum. Chlorophyll is attached to the thylakoids contained in chloroplasts, chlorophyll plays a direct role in the light reaction of photosynthesis that occurs in the thylakoid,

chlorophyll captures energy from sunlight which is then transferred to the reaction center and converts it into chemical energy (Salisbury & Ross, 1995). This misconception happensbecause most students do not understand the function of chlorophyll, students only know that chlorophyll is an important element in the photosynthesis process (Svandova, 2017).

In the concept of types and reaction times in the photosynthesis proccess, student who experienced misconceptions were 55%. Most of the students were correct that the reaction that occurred was a dark reaction, but the students were still having misconceptions in determining the time of the dark reaction, students assumed that the dark reaction occurred at night on the grounds that the dark reaction required high CO2 levels at night. This is in line with research conducted by Lonergan (2002) which states that misconceptions regarding the timing of dark reactions are a misconception that is still widely found in school or college level students, students understand that dark reactions from the Calvin cycle occur in dark conditions at night. . The correct concept regarding the timing of dark reactions is that dark reactions can last throughout the day because dark reactions are reactions that do not depend on light to fix CO2. A dark reaction can occur when there is a substrate in the form of a CO2 compound that will be fixed by RuBP to be reduced to glucose with the help of energy in the form of ATP and NADPH produced from the light reaction (Yuliani, 2017).

The causes of misconceptions based on interviews conducted with biology teacher comes from learning at the previous level. In addition, context also plays a role as a cause of misconceptions in students (Ibrahim, 2012). The concepts contained in the photosynthetic sub- material are quite complex and abstract so that students have difficulty in understanding these concepts. Misconceptions experienced by students tend to be difficult to change or are permanent in nature so that they can affect further teaching and learning activities. Misconceptions that occur in students must be prevented and addressed immediately because misconceptions can cause misunderstanding or confusion in understanding a scientific concept so that it can reduce student learning outcomes (Setiawati et al., 2014).

CONCLUSION

Based on the results of the research on the profile of students' misconceptions in the photosynthesis submission using a four-tier diagnostic test in class XII MIPA 3 and XII MIPA 4 Senior High School 1 Tarik, it

can be concluded that students experience misconceptions by 45.5%, students understand concepts by 28%, and students who do not understand the concept is 26.5%. As much 46.7% of students had high misconception, 29.8% of students had moderate misconception, and 23.5% of students had low misconception.

SUGGESTION

The suggestion from the researcher to prevent the misconceptions is the teachers must use various learning methods that are in accordance with the characteristics of the concept to be taught to students and are supported by learning media to make it easier for students to understand the material being taught especially at the concept function of chlorophyl. In addition, references such as manuals used are not only limited to one number, but by adding reference sources related to the material being taught to make it easier for students to obtain information.

ACKNOWLEDGMENT

REFERENCES

Arikunto, S. 2010. *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta

Asnunsa, M. 2016. Identifikasi Miskonsepsi Siswa Kelas VIII SMP Negeri 9 dan 25 Bandar Lampung Tahun Ajaran 2015/2016 Pada Materi Proses Perolehan Nutrisi dan Transformasi Energi Pada Tumbuhan Hijau. *Skripsi*. FKIP Universitas Lampung.

Fitriana, N. 2012. Analisis Miskonsepsi Siswa SMA Kelas XI pada Konsep Stoikiometri. *Skripsi*. UIN Syarif Hidayatullah Jakarta.

Gurel, D.K., Eryilmaz, A., MscDermoot, L.C. 2015. A Review and Comparison to Diagnostic Instruments to Identify Students' Misconceptions in Science. *Eurasia Journal of-Mathematics, Science and Technology Education*. Vol.11, No.5, page: 989- 1008.

Handoko, R. & Sipahutar, H., 2016. Analisis Miskonsepsi pada Buku Teks Biologi SMA Kelas X Berbasis Kurikulum Tingkat Satuan Pendidikan 2006 dan Kurikulum 2013 di Kota Tebing Tinggi. *Jurnal Pelita Pendidikan,* 4(1), pp. 39-47.

Hasanah, N.N., Supeno., Wahyuni, S. 2017. Kekuatan Retenso Siswa dalam Pembelajaran Fisika Pada Pokok Bahasan Momentum dan Impuls Menggunakan LKS Berbasis Mind Mapping. *Jurnal Pembelajaran dan Pendidikan Sains*. Vol 2, No.1, Hal: 25 - 32.

Ibrahim, M. 2012. *Konsep, Miskonsepsi dan Cara Pembelajarannya*. Surabaya: Unesa University Press.

Iriyanti, R., haji, S., Zamzali. 2017.Kemampuan Pemahaman Konsep & Penalaran Adaptif Siswa Kelas VIII SMP Negeri 2 Lubukliggai Melalui Pendekatan Pembelajaran Matematika Realistik dengan Tipe Structure Dyadic Method. *Jurnal Pendidikan Matematika Raflesia*. Vol. 2, No. 1, hal : 65-82.

Kirbulut, Z.D., dan Geban, O. 2014. Using Three tier Diagnostic Test to Asses Student's Misconception of States of Matter. *Eurasia Journal of Mathematic, Science and technology Education*. Vol 10 No 5. Page 509-521.

Luciana, N.A. 2017. Analisis Miskonsepsi Siswa dengan Menggunakan Bagan Dikotomi Konsep Pada Mata Pelajaran IPA Biologi Materi Fotosintesis Siswa Kelas VIII SMP Negeri 26 Bandar Lampung. *Skripsi*. UIN Raden Intan Lampung.

Machsunah, A. A. & Yuliani. 2019. Profil Miskonsepsi Siswa Pada Materi Fotosintesis dan Respirasi Tumbuhan Menggunakan Three-tier Diagnostic Test. *BioEdu*. Vol. 8 No. 2, hal : 2 - 3

Nusantari, E. 2015. Kajian Faktor yang Mempengaruhi Retensi Siswa SMA (Analisis Hasil Penelitian Eksperimen dan PTK). Artikel Penelitian Prodi Pendidikan Biologi Universitas Negeri Gorontalo.

Pesman, H., & Eryilmaz, A. 2010. Development of a three-tier test to assess misconceptions about simple electric circuits. *The Journal of Educational Research*. Vol. 103 (3): 208-222.

Salisbury, F. B. & Clean W. Ross. 1995. *Fisiologi Tumbuhan*. Bandung: ITB.

Sandika, B. 2020. Identification of Student's Misconception in The Topic of Population using Four-tier Diagnostic Test. *Jurnal Inovasi Pembelajaran Biologi*. Vol. 1 No.1 Hal: 2

Setiawati, G. A. D. Arjaya, I. B. A. Ekayanti, N. W. 2014. Identifkasi Miskonsepsi dalam Materi Fotosintesis dan Respirasi Tumbuhan pada

Siswa Kelas IX SMP di Kota Denpasar. *BaktiSaraswati*, 17-31.

Susanti. R., Rustaman, N.Y., Redjeki, S. 2010. *Profile Material Difficulty Level of Plant Physiology According to Prospective Biology Teachers*. Proceeding of The 4 th International Seminar on Science Education.

Svandova, K. 2014. Secondary Scool Student's Misconceptions about Photosynthesis and Plant Respiration: Pleminary Results. *Eurasia Journal of Mathematics, Science and Technology Education*. Vol. 10, No.1 , page : 59-67.

Tapilouw, F., Setiawan, W. 2008. Meningkatkan Pemahaman & Retensi Siswa dengan Pembelajaran Berbasis Multimedia Interaktif. *Jurnal Pendidikan Teknologi Informasi dan Komunikasi*. Vol 1 No.2, hal : 19-26.

Wahyuni. 2013. Diagnosis Tingkat Kesulitan Belajar Siswa Terhadap Pokok Bahasan Metabolisme Siswa Kelas XII IPA MA. Syeikh Yusuf Kabupaten Gowa. *Skripsi*. Fakultas Tarbiyah dan Keguruan UIN Alauddin Makassar.

Yuliani. 2017. *Metabolisme Tumbuhan*. Surabaya: Unesa University Press