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Analysis and reconstruction of student worksheets based on vee diagrams of biotechnology concept

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ABSTRACT

Planning is needed in practicum to connect students' conceptual and procedural knowledge through well-structured student worksheets. This can be achieved by using the Vee diagram. Vee diagram is a model that describes the relationship between conceptual and procedural understanding in building scientific knowledge. Through Vee diagrams, students can learn that knowledge comes from events/problem objects. This study aims to analyze and reconstruct student worksheets on Biotechnology concepts focused on making yogurt in several High School Biology textbooks. This study is a descriptive-qualitative method through the stages of ANCOR (Analysis, Trial and Reconstruction). Samples were taken using a purposive method. Research shows that based on results of analysis of 6 student worksheets from various publishers referring to aspects of relevance to the curriculum, structural, practical, and knowledge construction aspects of Vee diagrams, respectively, 71%, 68%, 79% (good category) and 50% (fairly good category). Thus, it can be concluded that in general, the student worksheets are not sufficiently capable of meeting the demands of the curriculum and assisting students in constructing knowledge. Therefore, it is necessary to reconstruct and develop student worksheets that have been analyzed and tested to produce better student worksheet that fulfill every aspect specified above.

INTRODUCTION

Education is very important and beneficial for everyone's life because education can change the way of thinking and life of many people to a better condition. With education, a person will gain various kinds of knowledge so that education can form a quality human being (Indy, 2019). Current educational developments emphasize independent and effective learning. With education, students can gain knowledge from their understanding (Lahra et al., 2017). One type of education is biology education. Biology education is a learning process that can develop students' potential to interact with the real natural environment. Biology is a field of science that studies living creatures and all their life. Biology is not only learned through theory but is closely related to practical activities so that students discover facts, build concepts, and discover new values through the process. So, studying Biology is always closely related to practicums or experiments (Ayuni et al., 2018).

Practicum is a process of gaining meaningful knowledge through direct activities and thoughts, therefore planning is needed in practicum to connect the conceptual and procedural or methodological sides (Putra et al., 2024). Theoretically, a practicum is carried out to develop students' potential to understand cognitive skills, psychomotor skills, and affective skills (Hindriana, 2016). Learning through practicums has a high potential in helping to learn scientific knowledge and how to build or reconstruct that knowledge (Saputro et al., 2020). According to Supriatno (2018), practicum learning is not only about learning about content but also the process of providing learning experiences so that you can build skills to gain knowledge. Practical learning can develop creativity and innovation, build critical thinking skills, build cooperation and train students' communication skills. This is supported by research of Shana & Abulibdeh (2020) showing that the grades and understanding of students taught using practical learning are better than without using practical learning. Research by Royani et al., (2018) also shows that direct practicum-based learning can improve students' science process skills and critical thinking abilities.

According to Safdar (2013), the objectives of practical activities in learning are: (1) Providing practical experience on how to use scientific methods to make observations, generate hypotheses, and conduct experiments to obtain evidence that supports or refutes the hypothesis; (2) Proficient in practical work, using practical equipment, and able to apply scientific theories. Practical activities are also believed to improve students' attitudes and motivation towards learning effectiveness and are more enjoyable than other teaching and learning activities (Abraham & Millar, 2008). Effective practicum activities can also improve students' scientific attitudes and science process skills (Suryaningsih, 2017).

However, in practice, practicum experiences in most schools cannot provide meaningful experiences for students because practicums are usually carried out more to clarify the concepts students are learning (Basri et al., 2023; Qonita et al., 2021). This statement is supported by Supriatno (2013) who states that practicum activities are generally carried out deductively using an expository model, usually known as verification or confirmation (Hindriana, 2016). Safdar (2013) quotes Ausubel's theory, that meaningful learning occurs when new knowledge is linked to what students already know. Therefore, before planning a practicum, it is important to connect new knowledge with several concepts that students already know (initial knowledge). Students' initial knowledge greatly influences how students can behave scientifically in solving problems, thinking critically, and building new concepts (Sunariyati et al., 2018).

Vee diagram is a model that describes the relationship between conceptual and procedural understanding in building scientific knowledge and the processes by which that knowledge is produced. Thus, students can find the meaning that knowledge comes from events/problem objects observed by Novak & Gowin (2006). When making a Vee diagram, the right side and left side must be connected. When making records must be following the concepts to obtain transformations that lead to valid knowledge claims. Likewise, making data transformations must

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be related to principles and knowledge claims as well as related to theory and following the focus question. If everything is interconnected, meaningful knowledge will be obtained from the observed events/objects (Gencer, 2014). Biology practical learning based on Vee diagrams is designed to reduce students' cognitive load in designing experiments so that practical activities become meaningful because students can see the interesting side of both the conceptual and procedural parts.

The research results of Furqan et al. (2016) showed that a practicum guide module containing laboratory activity designs was able to improve science process skills and student learning outcomes. Apart from that, research by Candra & Hidayati (2020) also shows that practicum can improve process skills in the form of skills in observing, classifying, communicating, measuring, predicting, and concluding, as well as improving process skills in the form of skills in using practicum equipment. The results of Hindriana's (2020) research show that the quality of the vee diagram-based practical worksheet that was developed obtained an average score of 3.73 in the very good category so the vee diagram-based practical worksheet is worthy of being tried out. The results of the vee diagram-based practical worksheet assessment also received a good response from teachers who will implement the practical worksheet resulting from the development. So, based on several research results, it can be seen that practical activities are able to provide meaningful learning for students so that students are able to reconstruct their own understanding.

One of the high school biology concepts that is the focus of this research is Biotechnology concept. This concept is one of the materials that is very important for students to understand because it has many applications in everyday life. Biotechnology is divided into 2 types, namely conventional and modern biotechnology. In the independent curriculum, Biotechnology is one of the biology learning concepts that will be studied by students in class X. This is different from the 2013 curriculum because Biotechnology concept is learned in class XII. Learning outcomes for Biotechnology concept in the independent curriculum are that students can be responsive to global issues and play an active role in providing problem solutions. These abilities include observing, questioning, and predicting, planning and conducting research, processing and analyzing data and information, evaluating and reflecting, and communicating in the form of simple projects or visual simulations using available technological applications related to biotechnology in everyday life. The element of scientific understanding that students must have at the end of phase E, students have the ability to create solutions to problems based on local or global issues from their understanding of the application of biotechnology (Kemendikbud, 2022).

Based on the background, research was conducted to analyze several student worksheets in high school biology textbooks. Next, reconstruction of the student worksheets results from the analysis is carried out by referring to the Vee diagram. Analysis and reconstruction refer to aspects of relevance to the curriculum, structural, practical, and knowledge construction. This research will only focus on the sub-concept of making cow's milk yogurt which is an example of conventional biotechnology.

METHODS

The method used in this research is a descriptive-qualitative method through the ANCOR (Analysis, Trial, and Reconstruction) stages. The object of this research is the student worksheets on Biotechnology material that focuses on conventional Biotechnology, namely making yogurt. Samples were taken using a purposive sampling technique based on various considerations by researchers regarding the research object (Sugiyono, 2019). The considerations used by the researchers were Biology textbooks for high school classes X and XII which contained student worksheets about making yogurt. The samples used were 6 textbooks with publication years from 2007 to 2022, including 5 high school biology textbooks for class XII and 1 high school biology

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textbook for class based on the 2013 revised 2016 curriculum. Meanwhile, 1 class X high school biology textbook is prepared based on the independent curriculum.

Research activities are carried out based on ANCOR stages. In the first stage of ANCOR, the researcher carried out an analysis of the student worksheets using instruments adapted and developed by several experts and validated by expert lecturers. The aspects that are the focus of the instrument can be seen in Table 1. The second stage is that the researcher conducted trials on the 6 student worksheets that had been collected without changing the contents of the student worksheets to find out the weaknesses in the design of the laboratory activities. In the third stage, the researcher reconstructed the student worksheets based on the analysis and trials that had been carried out by the researcher. After that, the researcher tested the reconstructed student worksheet on students to find out whether the design of student worksheets could be carried out by students or not and the shortcomings of the student worksheets. In the final stage, researchers reconstructed the new student worksheet based on the test results. So, after carrying out the ANCOR stage, researchers can create a new student worksheet that fulfills all aspects in Table 1.

Table 1. Aspects analyzed in the research instrument

Aspect	Indicator	Maximum Score
Relevance to the Curriculum	Competence with learning outcomes	2
	Content with learning outcomes	2
Structural Aspects	Title	4
	Practical objectives	4
	Work procedures	4
Practical	Availability of tools for activity needs	4
	Availability of materials for activity needs	4
Vee Diagram Knowledge Construction (Novak & Gowin, 2006)	Focus question	3
	Objects/ events	3
	Theory, Principles, and Concepts	4
	Records/ transformations	4
	Knowledge claims	4

DKL feasibility assessment guidelines use assessment guidelines from Sani (2016) and Table 2 show eligibility criteria of student worksheets.

$$\textbf{Percentage} = \frac{score\ obtained}{Maximum\ score} \text{ x } 100\ \%$$

Table 2. Eligibility criteria of student worksheets

Criteria	Percentage
Excellent	81% - 100%
Good	61% - 80%
Fairly good	41% - 60%
Poor	21% - 40%
Very poor	0% - 20%

RESULTS AND DISCUSSION

Analysis of relevance to the curriculum aspects

The student worksheets regarding making yogurt which has been collected from several class X and XII high school biology textbooks must be analyzed first using several aspects as in Table 1. In the aspect of relevance to the curriculum, researchers analyzed the relevance of 6 student

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worksheets which had been taken from several publishers of high school Biology textbooks for classes X and XII with the applicable curriculum, namely the relevance of competencies and content to learning outcomes (LO). The results of the analysis of aspects of the relevance of several student worksheets to the independent curriculum can be seen in Table 3.

Table 3. The analysis results of relevance to the curriculum aspects

Parameter	Student Worksheets (SW)						Average
	Class XII					Class X	
	2006	2013		2013 Revised		independent curriculum	
	I	II	III	IV	V	VI	
Competence with learning outcomes	2	2	1	2	1	1	1,5
Content with learning outcomes	1	2	1	1	1	2	1,33
Total Score	3	4	2	3	2	3	2,83
Percentage	75%	100%	50%	75%	50%	75%	71%

Based on Table 3, the results of the analysis of aspects of relevance to the curriculum generally show that the competencies developed in 6 student worksheets from 4 different curricula do not meet the minimum learning outcomes standards with an average of 1.5. Where 3 books have a score of 2, namely books I, II, and IV, indicating that the competencies contained in student worksheets have reached the minimum learning outcomes standard in the independent curriculum. Meanwhile, books III, V, and VI were given a score of 1 because the competencies contained in the student worksheets have not yet reached the minimum learning outcomes standard in the independent curriculum. The content suitability parameters with learning outcomes show that books II and VI already contain content that is in accordance with basic competencies, while books I, III, IV, and V do not contain content that is compatible with basic competencies in the curriculum used. So, in general, the content developed in 6 student worksheets from 4 different curricula does not meet the minimum learning outcomes standards with an average of 1.33. In table 3 above it can also be seen that for the student worksheets feasibility test based on aspects of relevance to the curriculum, student worksheet II is classified as Excellent with a percentage of 100%, student worksheets I, IV, VI is classified as good with a percentage of 75% and student worksheets III and V are classified as fairly good with a percentage 50%.

Analysis of structural aspects

The results of the analysis of the structural aspects of each student worksheet can be seen in Table 4.

Table 4. The analysis results of structural aspects

Parameter	Student Worksheets (SW)						Average
	Class XII					Class X	
	2006	2013		2013 Revised 2016		independent curriculum	
	I	II	III	IV	V	VI	
Title	3	3	3	3	3	3	3
Practical objectives	0	3	2	3	2	3	2,17
Work procedures	3	3	3	3	3	3	3
Total Score	6	9	8	9	8	9	8,17
Percentage	50%	75%	67%	75%	67%	75%	68%

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Based on Table 4, it can be seen that the average value for suitability of the student worksheets' title is 3, meaning that the title contains essential concepts and describes activities but is not yet in the form of a question sentence. A good practicum title must contain essential concepts, describe the activity, and be in the form of a question sentence (Nurulia et al., 2022; Lestari & Cintamulya, 2022). If practicum title in Student worksheet contains essential concepts, describe the activity, and be in the form of a question sentence, it can be given a score of 4. The average value for suitability of objectives is 2.17, meaning that the objectives are relevant to the curriculum and focus on activities that only construct knowledge factual. A good practicum objective will be given a score of 4, if the objective is relevant to the curriculum and focuses on activities that construct factual, conceptual, and procedural knowledge. In Table 4 we can see that student worksheet 1 gets a score of 0 because there are no objectives listed on the LAD. Student worksheet III and V get a score of 2 because the objectives are relevant to the curriculum and focus on activities that construct factual knowledge only. Meanwhile, student worksheet II, IV, and VI get a score of 3 because the objectives are relevant to the curriculum and focus on activities that construct factual and conceptual knowledge only. For the suitability analysis of work procedures, all student worksheets received a score of 3 because the procedures were relevant to the objectives, structured and logical, gave rise to objects and phenomena but did not support the construction of knowledge/competence. A student worksheet is said to have good procedures and is given a score of 4 if the procedures are relevant to the objectives, structured and logical, generating objects and phenomena that support the construction of knowledge/competence. In table 4 above it can also be seen that for the student worksheet feasibility test based on structural aspects, student worksheets II, III, IV, V, VI are classified as good with a percentage between 61% - 80% and student worksheet I is classified as fairly good with a percentage of 50%.

Analysis of practical aspects

The results of the analysis of practical aspects of several student worksheets can be seen in Table 5.

Table 5. The analysis results of practical aspects

Parameter	Student Worksheets (SW)						Average
	Class XII					Class X	
	2006	2013		2013 Revised		independent curriculum	
	I	II	III	IV	V	VI	
Availability of Tools in School Laboratories	3	3	3	3	3	3	3
Availability of materials in School Laboratories	3	3	3	3	3	3	3
Total Score	6	6	6	6	6	6	6
Percentage	75%	100%	75%	75%	75%	75%	79%

Based on Table 5, it can be seen that several tools used for practicum based on student worksheets were given a score of 3 because there are still several tools that are not yet available in the school laboratory and must be provided from outside the school, such as jars with lids, stoves, pans, and jar coverings. Apart from that, the availability of materials was also given a score of 3 because there are still some materials that are not available in the laboratory and must be provided from outside the school, such as UHT milk, *biocult* which contains the starter bacteria *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. In Table 5 above it can also be seen that for the student worksheets feasibility test based on practical aspects, student worksheet II is

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classified as Excellent with a percentage of 100%, and student worksheets I, III, IV, V, VI are classified as good with a percentage between 61% - 80%.

Analysis of knowledge construction aspects

In the aspects of knowledge construction based on vee diagrams by Novak & Gowin (2006), researchers analyzed focus questions, objects/events, theories, principles, and concepts, records/transformations, and knowledge claims. The results of the analysis of knowledge construction aspects based on Vee diagrams for each student worksheet can be seen in Table 6.

Table 6. The analysis results of Vee diagram knowledge construction aspects

Parameter	Student Worksheets (SW)						Average
	Class XII					Class X	
	2006	2013		2013 Revised		independent curriculum	
	I	II	III	IV	V	VI	
Focus question	2	2	2	2	2	2	2
Objects/ events	2	2	1	2	1	1	1,5
Theory, principles, and concepts	2	2	2	2	2	2	2
Records/ transformations	1	3	1	1	1	1	1,33
Knowledge claims	2	3	2	2	2	2	2,17
Total	9	12	8	9	8	8	9
Nilai	50%	67%	44%	50%	44%	44%	50%

Based on Table 6, it can be seen that the average focus question in all student worksheets is 2 because focus questions can be identified and contain a conceptual part but do not support the observation of the main object or event. A good focus question must be identifiable, and include a conceptual part that can be used to support the main event and strengthen the object (Indrawati et al., 2024). In the parameters objects/events of student worksheets III, V, and VI are given a score of 1 because the main event or object can be identified and is consistent with the focus question, or events and objects can be identified but are not consistent with the focus question. Meanwhile, student worksheets I, II, and IV were given a score of 2 because an identifiable object accompanied the main event and was consistent with the focus question but did not support what was to be written. So, the average value of Objects/events for all student worksheet is 1.5.

Based on the parameters theory, principles, and concepts all student worksheet were given a score of 2 because they contain concepts, only contain one principle (conceptual or methodological) and a relevant theory can be identified. Meanwhile, theory, principles, and concepts must contain concepts, contain two forms of principles (conceptual and methodological), and relevant theories can be identified (Anggraeni et al., 2024). The records/transformations parameter for student worksheets I, III, IV, V, and VI were given a score of 1 because recording activities can be identified, but are not consistent with the main question or main activity. Student worksheet II was given a score of 3 because recording activities can be identified and are by the main event but the transformation is not consistent with the focus question. A student worksheet is said to have good records/transformations if the recording activities can be identified in the main activities, the transformations are consistent with the focus question, and the level of quality/ability of the students (Afiyatusyifa et al., 2020). So, the average value of records/transformations for all student worksheet is 1.33.

The knowledge claim parameter for LAD I, III, IV, V, and VI is given a score of 2 because the knowledge claim is not consistent with the data or events recorded and transformed or the

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knowledge claim already contains a conceptual side. Student worksheet II was given a score of 3 because the knowledge claim contains concepts that are by the focus question and are by the results of recording and transformation but the knowledge claim has not yet led to the formation of a new focus question. So, the average value of the knowledge claim parameter for all student worksheet is 2.17. In Table 6 above it can also be seen that for the student worksheets feasibility test based on the vee diagram-based knowledge construction aspect, student worksheet II is classified as good with a percentage of 67%, and student worksheets I, III, IV, V, VI are classified as fairly good with a percentage between 41% - 60%.

Trial result of student worksheets

Trials were carried out on 6 student worksheets from various types of publishers. Based on the results of trials carried out by researchers, there are still many things that need to be changed from the existing student worksheets, such as tools and materials, work procedures, tables of observation results, and questions on the student worksheets. Regarding tools and materials, some student worksheets do not use heating devices or stoves to heat milk and do not use materials that are easy for students to find, such as UHT cow's milk and *biokult*. In the work procedures, some student worksheets do not use structured work procedures and language that is easy to understand, which can cause students to be confused when carrying out practicums. Apart from that, the object of the phenomenon is still not visible in each student worksheets because in the student worksheets there is no visible difference in milk fermented with and without using *Streptococcus thermophilus* and *Lactobacillus bulgaricus* starters. In this case, it is a very important phenomenon object to be demonstrated in conventional biotechnology practicums for making yogurt, namely the role of bacteria so that students can find the differences in fermented cow's milk using a starter and without using a starter, the bacteria *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. So, this is one of the changes made by the author in the SW that will be reconstructed.

Another thing that needs to be improved is the observation results table because most student worksheets do not include an observation results table so this really needs to be improved. Observation results table is very important so that students can record quantitatively and qualitatively based on the results of observations (Kaeedi et al., 2023; Matsna et al., 2023). So, there is important data that students will find when carrying out practicums or experiments. Some student worksheets also do not include questions, even though these questions are very important for reconstructing students' understanding after carrying out practicums or experiments. The questions included in the student worksheets must be able to be answered by students based on the practicum that has been carried out (Rahmawati et al., 2022; Siregar et al., 2023).

Reconstruction results of student worksheet

Based on the results of the analysis using instruments for aspects of relevance to the curriculum, structural, practical, and vee diagram knowledge construction, it was found that the student worksheet was not capable enough to meet the demands of the curriculum and assist students in constructing knowledge. It is very necessary to reconstruct and develop the student worksheet which has been analyzed and tested so that it can produce a good student worksheet and fulfills every aspect such as aspects of relevance to the curriculum, structural, practical, and knowledge construction of vee diagrams as well as achieving appropriate learning activity objectives. An example of reconstruction results from SW can be seen in Figure 1 and Figure 2.

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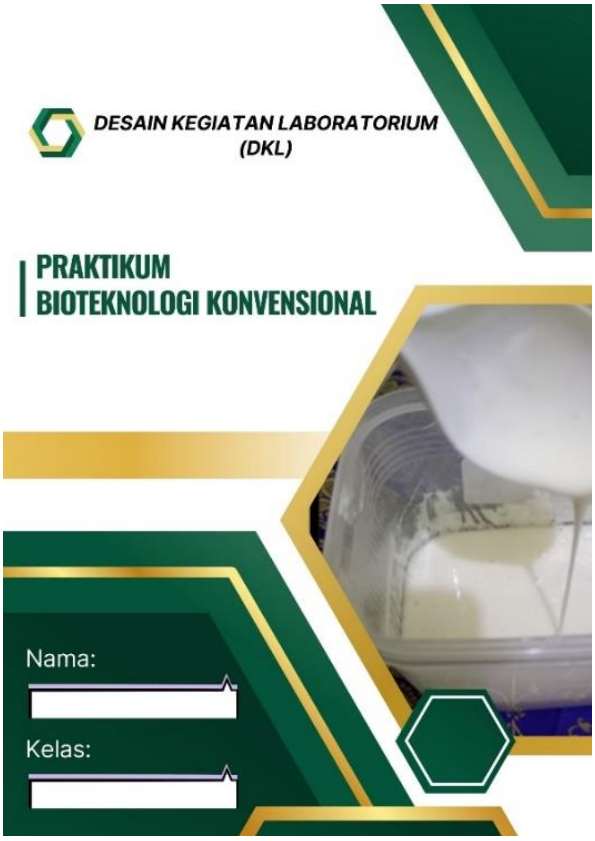
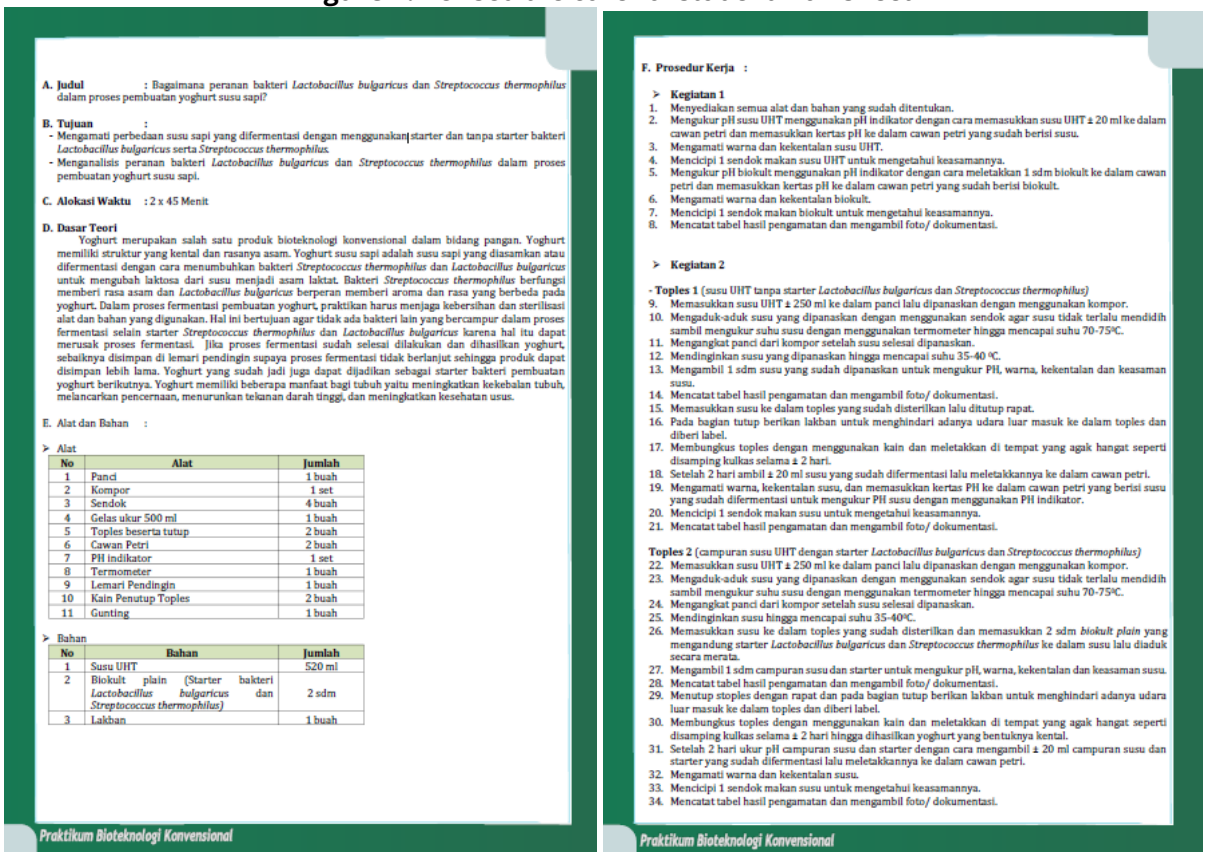


Figure 1. Revised the cover of student worksheet



A. Judul : Bagaimana peranan bakteri *Lactobacillus bulgaricus* dan *Streptococcus thermophilus* dalam proses pembuatan yoghurt susu sapi?

B. Tujuan :
- Mengamati perbedaan susu sapi yang difermentasi dengan menggunakan starter dan tanpa starter bakteri *Lactobacillus bulgaricus* serta *Streptococcus thermophilus.*
- Menganalisis peranan bakteri *Lactobacillus bulgaricus* dan *Streptococcus thermophilus* dalam proses pembuatan yoghurt susu sapi.

C. Alokasi Waktu : 2 x 45 Menit

D. Dasar Teori

Yoghurt merupakan salah satu produk bioteknologi konvensional dalam bidang pangan. Yoghurt memiliki struktur yang kental dan rasanya asam. Yoghurt susu sapi adalah susu sapi yang diasamkan atau difermentasi dengan cara menumbuhkan bakteri *Streptococcus thermophilus* dan *Lactobacillus bulgaricus* untuk mengubah laktosa dari susu menjadi asam laktat. Bakteri *Streptococcus thermophilus* berfungsi memberi rasa asam dan *Lactobacillus bulgaricus* berperan memberi aroma dan rasa yang berbeda pada yoghurt. Dalam proses fermentasi pembuatan yoghurt, praktikan harus menjaga kebersihan dan sterilisasi alat dan bahan yang digunakan. Hal ini bertujuan agar tidak ada bakteri lain yang bercampur dalam proses fermentasi selain starter *Streptococcus thermophilus* dan *Lactobacillus bulgaricus* karena hal itu dapat merusak proses fermentasi. Jika proses fermentasi sudah selesai dilakukan dan dihasilkan yoghurt, sebaiknya disimpan di lemari pendingin supaya proses fermentasi tidak berlanjut sehingga produk dapat disimpan lebih lama. Yoghurt yang sudah jadi juga dapat dijadikan sebagai starter bakteri pembuatan yoghurt berikutnya. Yoghurt memiliki beberapa manfaat bagi tubuh yaitu meningkatkan kekebalan tubuh, melancarkan pencernaan, menurunkan tekanan darah tinggi, dan meningkatkan kesehatan usus.

E. Alat dan Bahan :

➢ Alat

No	Alat	Jumlah
1	Panci	1 buah
2	Kompor	1 set
3	Sendok	4 buah
4	Gelas ukur 500 ml	1 buah
5	Toples beserta tutup	2 buah
6	Cawan Petri	2 buah
7	PH indikator	1 set
8	Termometer	1 buah
9	Lemari Pendingin	1 buah
10	Kain Penutup Toples	2 buah
11	Gunting	1 buah

➢ Bahan

No	Bahan	Jumlah
1	Susu UHT	520 ml
2	Biokult plain (Starter bakteri *Lactobacillus bulgaricus* dan *Streptococcus thermophilus)*	2 sdm
3	Lakban	1 buah

Praktikum Bioteknologi Konvensional

F. Prosedur Kerja :

➢ **Kegiatan 1**

1. Menyediakan semua alat dan bahan yang sudah ditentukan.
2. Mengukur pH susu UHT menggunakan pH indikator dengan cara memasukkan susu UHT ± 20 ml ke dalam cawan petri dan memasukkan kertas pH ke dalam cawan petri yang sudah berisi susu.
3. Mengamati warna dan kekentalan susu UHT.
4. Mencicipi 1 sendok makan susu UHT untuk mengetahui keasamannya.
5. Mengukur pH biokult menggunakan pH indikator dengan cara meletakkan 1 sdm biokult ke dalam cawan petri dan memasukkan kertas pH ke dalam cawan petri yang sudah berisi biokult.
6. Mengamati warna dan kekentalan biokult.
7. Mencicipi 1 sendok makan biokult untuk mengetahui keasamannya.
8. Mencatat tabel hasil pengamatan dan mengambil foto/ dokumentasi.

➢ **Kegiatan 2**

- **Toples 1** (susu UHT tanpa starter *Lactobacillus bulgaricus* dan *Streptococcus thermophilus)*

9. Memasukkan susu UHT ± 250 ml ke dalam panci lalu dipanaskan dengan menggunakan kompor.
10. Mengaduk-aduk susu yang dipanaskan dengan menggunakan sendok agar susu tidak terlalu mendidih sambil mengukur suhu susu dengan menggunakan termometer hingga mencapai suhu 70-75ºC.
11. Mengangkat panci dari kompor setelah susu selesai dipanaskan.
12. Mendinginkan susu yang dipanaskan hingga mencapai suhu 35-40 ºC.
13. Mengambil 1 sdm susu yang sudah dipanaskan untuk mengukur PH, warna, kekentalan dan keasaman susu.
14. Mencatat tabel hasil pengamatan dan mengambil foto/ dokumentasi.
15. Memasukkan susu ke dalam toples yang sudah disterilkan lalu ditutup rapat.
16. Pada bagian tutup berikan lakban untuk menghindari adanya udara luar masuk ke dalam toples dan diberi label.
17. Membungkus toples dengan menggunakan kain dan meletakkan di tempat yang agak hangat seperti disamping kulkas selama ± 2 hari.
18. Setelah 2 hari ambil ± 20 ml susu yang sudah difermentasi lalu meletakkannya ke dalam cawan petri.
19. Mengamati warna, kekentalan susu, dan memasukkan kertas PH ke dalam cawan petri yang berisi susu yang sudah difermentasi untuk mengukur PH susu dengan menggunakan PH indikator.
20. Mencicipi 1 sendok makan susu untuk mengetahui keasamannya.
21. Mencatat tabel hasil pengamatan dan mengambil foto/ dokumentasi.

Toples 2 (campuran susu UHT dengan starter *Lactobacillus bulgaricus* dan *Streptococcus thermophilus)*

22. Memasukkan susu UHT ± 250 ml ke dalam panci lalu dipanaskan dengan menggunakan kompor.
23. Mengaduk-aduk susu yang dipanaskan dengan menggunakan sendok agar susu tidak terlalu mendidih sambil mengukur suhu susu dengan menggunakan termometer hingga mencapai suhu 70-75ºC.
24. Mengangkat panci dari kompor setelah susu selesai dipanaskan.
25. Mendinginkan susu hingga mencapai suhu 35-40ºC.
26. Memasukkan susu ke dalam toples yang sudah disterilkan dan memasukkan 2 sdm *biokult plain* yang mengandung starter *Lactobacillus bulgaricus* dan *Streptococcus thermophilus* ke dalam susu lalu diaduk secara merata.
27. Mengambil 1 sdm campuran susu dan starter untuk mengukur pH, warna, kekentalan dan keasaman susu.
28. Mencatat tabel hasil pengamatan dan mengambil foto/ dokumentasi.
29. Menutup stoples dengan rapat dan pada bagian tutup berikan lakban untuk menghindari adanya udara luar masuk ke dalam toples dan diberi label.
30. Membungkus toples dengan menggunakan kain dan meletakkan di tempat yang agak hangat seperti disamping kulkas selama ± 2 hari hingga dihasilkan yoghurt yang bentuknya kental.
31. Setelah 2 hari ukur pH campuran susu dan starter dengan cara mengambil ± 20 ml campuran susu dan starter yang sudah difermentasi lalu meletakkannya ke dalam cawan petri.
32. Mengamati warna dan kekentalan susu.
33. Mencicipi 1 sendok makan susu untuk mengetahui keasamannya.
34. Mencatat tabel hasil pengamatan dan mengambil foto/ dokumentasi.

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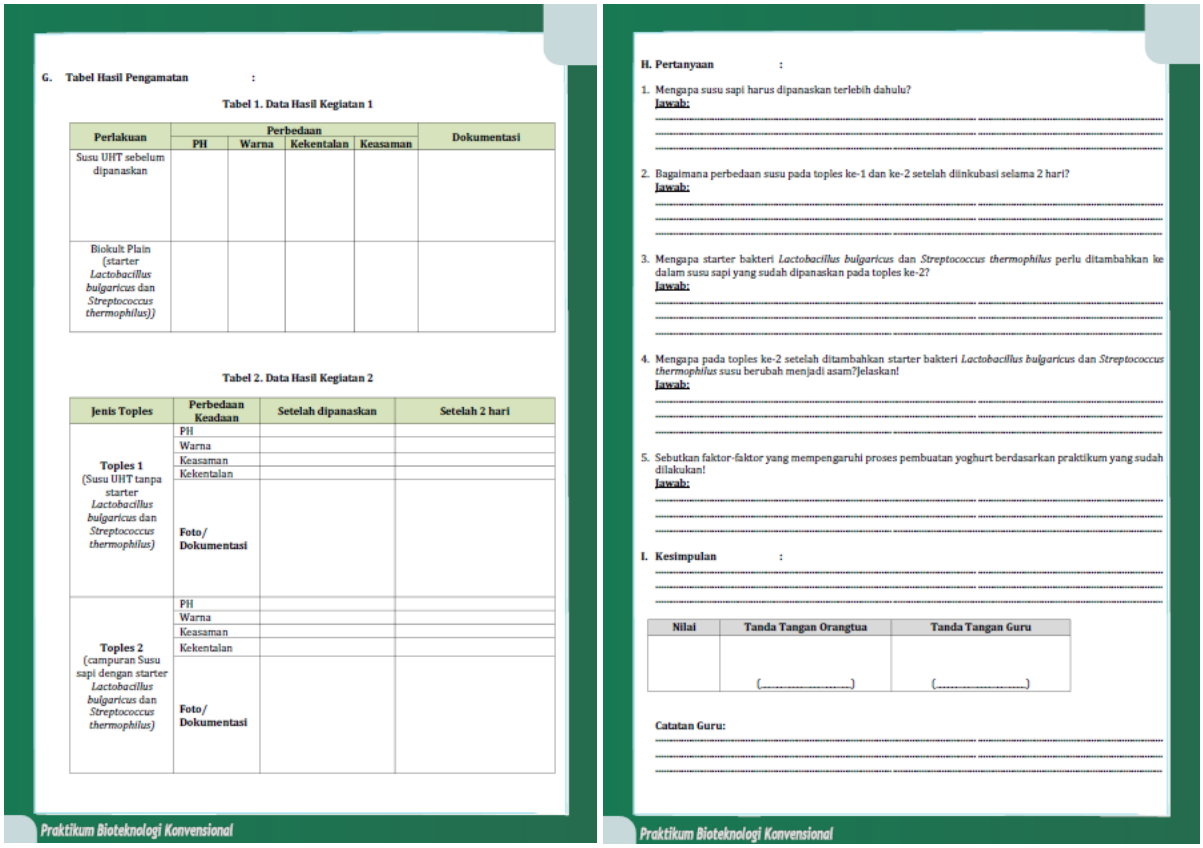

G. Tabel Hasil Pengamatan :

Tabel 1. Data Hasil Kegiatan 1

Perlakuan	Perbedaan				Dokumentasi
	PH	Warna	Kekentalan	Keasaman	
Susu UHT sebelum dipanaskan					
Biokult Plain (starter *Lactobacillus bulgaricus* dan *Streptococcus thermophilus)*)					

Tabel 2. Data Hasil Kegiatan 2

Jenis Toples	Perbedaan Keadaan	Setelah dipanaskan	Setelah 2 hari
Toples 1 (Susu UHT tanpa starter *Lactobacillus bulgaricus* dan *Streptococcus thermophilus)*	PH		
	Warna		
	Keasaman		
	Kekentalan		
	Foto/ Dokumentasi		
Toples 2 (campuran Susu sapi dengan starter *Lactobacillus bulgaricus* dan *Streptococcus thermophilus)*	PH		
	Warna		
	Keasaman		
	Kekentalan		
	Foto/ Dokumentasi		

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H. Pertanyaan :

1. Mengapa susu sapi harus dipanaskan terlebih dahulu?
   Jawab:
2. Bagaimana perbedaan susu pada toples ke-1 dan ke-2 setelah diinkubasi selama 2 hari?
   Jawab:
3. Mengapa starter bakteri *Lactobacillus bulgaricus* dan *Streptococcus thermophilus* perlu ditambahkan ke dalam susu sapi yang sudah dipanaskan pada toples ke-2?
   Jawab:
4. Mengapa pada toples ke-2 setelah ditambahkan starter bakteri *Lactobacillus bulgaricus* dan *Streptococcus thermophilus* susu berubah menjadi asam?jelaskan!
   Jawab:
5. Sebutkan faktor-faktor yang mempengaruhi proses pembuatan yoghurt berdasarkan praktikum yang sudah dilakukan!
   Jawab:

I. Kesimpulan :

Nilai	Tanda Tangan Orangtua	Tanda Tangan Guru
	(.....)	(.....)

Catatan Guru:

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Figure 2. Revised student worksheet

CONCLUSION

Based on the results of the analysis and trials that have been carried out on 6 student worksheets from various publishers, it can be concluded that the practical activities on conventional biotechnology concept, namely making yogurt, in most of the student worksheets are not sufficient to meet the demands of the curriculum and help students in constructing knowledge and have not yet given rise to phenomenon objects. clear. The results of the analysis of 6 student worksheets from various publishers using the instrument of relevance aspects to the curriculum averaged 71%, structural aspects averaged 68%, practical aspects averaged 79% in the good category, and aspects the average knowledge of Vee diagram construction is 50% in the fairly good category. Apart from that, in most of student worksheets there is no visible difference in milk incubated or fermented with and without using *Streptococcus thermophilus* and *Lactobacillus bulgaricus* starters. Meanwhile, this is a very important phenomenon object to be demonstrated in conventional biotechnology practicums for making yoghurt, namely the role of bacteria so that students can discover the differences in cow's milk fermented using a starter and without using the starter bacteria *Streptococcus thermophilus* and *Lactobacillus bulgaricus*. In addition, quantitative and qualitative data that students must find in most of student worksheets are not included. So, this really needs to be used to reconstruct the student worksheets so that it can develop a new student worksheet that fulfills aspects of relevance to the curriculum, structural, practical, and knowledge construction of vee diagrams.

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REFERENCES

Abraham, I., & Millar, R. (2008). Does practical work really work? A study of the effectiveness of practical work as a teaching and learning method in school science. *International Journal of Science Education*, *30*(14), 1945–1969.

Afiyatusyifa, F., Anggraeni, S., & Supriatno, B. (2020). Analisis lembar kerja siswa praktikum fotosintesis dengan uji SACHS: Students work sheet analysis of photosynthesis practicum with SACHS test. *BIODIK*, *6*(3), 352-360.

Anggraeni, P., Supriatno, B., & Gusti, U. A. (2024). Analisis kualitas lembar kerja siswa berbasis diagram vee pada praktikum SMA materi plasmolisis. *EDUPROXIMA (JURNAL ILMIAH PENDIDIKAN IPA)*, *6*(1), 27-34.

Ayuni, N. P. B., Zunaena, M., Oktaviani, R. D., Kristinah, N., & Yuliyati, S. (2018). Pengetahuan mahasiswa pendidikan biologi tentang peralatan laboratorium biologi. *Pendidikan Biologi*, *1*(1), 1–7.

Basri, R., Dongoran, P. H., Syafitri, D., Silaban, A. P. W., & Hayati, Z. (2023). Presepsi siswa kelas XII terhadap praktikum bioteknologi di sekolah menengah atas (SMA). *Biodik: Jurnal Ilmiah Pendidikan Biologi*, *9*(1), 116-122.

Candra, R., & Hidayati, D. (2020). Penerapan praktikum dalam meningkatkan keterampilan proses dan kerja peserta didik di laboratorium IPA. *Edugama: Jurnal Kependidikan Dan Sosial Keagamaan*, *6*(1), 26–37.

Furqan, H., Yuszrizal, & Saminan. (2016). Pengembangan modul praktikum berbasis inkuiri untuk meningkatkan keterampilan proses sains dan hasil belajar siswa kelas X di SMA Negeri 1 Bukit Bener Meriah. J*urnal Pendidikan Sains Indonesia*, *4*(2), 124-129.

Gencer, A. S. (2014). Analysing vee diagram reflections to explore pre-service science teachers' understanding the nature of science in biology. *Eurasia Journal of Mathematics, Science and Technology Education*, *10*(5), 437–446.

Hindriana, A. F. (2016). The development of biology practicum learning based on vee diagram for reducing student cognitive load. *JETL (Journal Of Education, Teaching and Learning)*, *1*(2), 61-65.

Hindriana, A. F. (2020). Pengembangan lembar kerja praktikum berbasis diagram vee guna memfasilitasi kegiatan laboratorium secara bermakna. *Quagga: Jurnal Pendidikan dan Biologi*, *12*(1), 62-68.

Indrawati, L., Supriatno, B., & Gusti, U. A. (2024). Analisis dan rekonstruksi desain kegiatan laboratorium (dkl) pada materi protista kelas x sma. *EDUPROXIMA (Jurnal Ilmiah Pendidikan IPA)*, *6*(1), 127-135.

Indy, R. (2019). Peran Pendidikan dalam proses perubahan sosial di Desa Tumaluntung Kecamatan Kauditan Kabupaten Minahasa Utara. *HOLISTIK, Journal Of Social and Culture*, *12*(4), 1–18.

Kaeedi, A., Esfahani, A. R. N., Sharifian, F., & Moosavipour, S. (2023). The quantitative and qualitative study of the effectiveness of the problem-based learning approach in teaching research methods. *Journal of University Teaching and Learning Practice*, *20*(5), 1-27.

Kemendikbud. (2022). Peraturan mentri pendidikan dan kebudayaan republik indonesia nomor 37 tahun 2022. Jakarta.

Lahra, A. S., Hasan, M., & Mursal, D. (2017). Pengembangan modul praktikum berbasis pendekatan open ended untuk meningkatkan kreativitas siswa. *Jurnal Pendidikan Sains Indonesia*, *5*(1), 36–43.

Lestari, W. A., & Cintamulya, I. (2022). Validity of mobile learning-based practicum instructions with a guide inquiry approach to improve critical thinking skills. *Edubiotik: Jurnal Pendidikan, Biologi dan Terapan*, *7*(2), 147-159.

Matsna, F. U., Rokhimawan, M. A., & Rahmawan, S. (2023). Analisis keterampilan proses sains siswa melalui pembelajaran berbasis praktikum pada materi titrasi asam-basa kelas XI SMA/MA. *Dalton: Jurnal Pendidikan Kimia dan Ilmu Kimia*, *6*(1), 21-30.

Novak, J. D & Gowin D. 2006. *Learning how to learn*: Cambridge University Press.

DOI: https://doi.org/10.17509/aijbe.v7i2.69559
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Nurulia, G. S., & Qomariyah, N. (2022). Pengembangan E-LKPD berbasis learning cycle 5E Materi sistem pencernaan untuk meningkatkan ketrampilan proses terintegrasi peserta didik kelas XI SMA. *Berkala Ilmiah Pendidikan Biologi (BioEdu)*, *11*(2), 285-293.

Putra, R. E., Hofifah, S. N., Maemunah, I., Purwanti, S. T., & Barmana, D. (2024). "ANKER" video prosedur K3 untuk meningkatkan kesadaran kerja di laboratorium mikrobiologi. *Jurnal Pengelolaan Laboratorium Pendidikan*, *6*(2), 133-144

Qonita, R., Hariz, A. R., & Wijayanti, E. (2021). Analisis pelaksanaan kegiatan praktikum biologi daring pada siswa SMA. *Bioilmi: Jurnal Pendidikan*, *7*(2), 83-92.

Rahmawati, T., Suhanda, H., Sabilla, F. I. A., & Suryatna, A. (2022). Implementation of practicum worksheets based on guided inquiry on the topic of colloids to improve students' science process skills. *JIPI (Jurnal IPA dan Pembelajaran IPA)*, *6*(4), 409-422.

Royani, I., Mirawati, B., & Jannah, H. (2018). Pengaruh model pembelajaran langsung berbasis praktikum terhadap keterampilan proses sains dan kemampuan berpikir kritis siswa. *Prisma Sains : Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika dan IPA IKIP Mataram*, *6*(2), 46-55.

Safdar, M. (2013). Make the laboratory work meaningful through concept maps and v diagram. *IOSR Journal of Research & Method in Education (IOSRJRME)*, *3*(2), 55–60.

Sani, Ridwan Abdullah. 2016. *Penilaian autentik*: PT. Bumi Aksara.

Saputro, B., Saerozi, M., & Ardhiansyah, F. (2020). Philosophical reflections: Critical analysis of learning strategies for science practicum during the covid-19 Pandemic. *IJORER: International Journal of Recent Educational Research*, *1*(2), 78-89.

Shana, Z., & Abulibdeh, E. S. (2020). Science practical work and its impact on students' science achievement. *Journal of Technology and Science Education*, *10*(2), 199–215.

Siregar, M. E., Masitoh, S., & Sumarno, A. (2023). Analysis of student worksheet needs in science practicum activities with problem-based learning model. *JSEP (Journal of Science Education and Practice)*, *7*(1), 26-36.

Sugiyono. (2016). *Metode penelitian pendidikan*: PT Rineka Cipta.

Sunariyati, S., Suatma, & Miranda, Y. (2018). Pengaruh praktikum biologi berbasis etnobiologi terhadap pemahaman konsep materi biologi dan pelestarian budaya lokal. *Proceeding Biology Education Conference*, *15*, 524–531.

Supriatno, B. (2018). Praktikum untuk membangun kompetensi. *Proceeding Biology Education Conference, 15*(1), 1-18.

Suryaningsih, Y. (2017). Pembelajaran berbasis praktikum sebagai sarana siswa untuk berlatih menerapkan keterampilan proses sains dalam materi biologi. *Jurnal Pendidikan Biologi*, *2*(2), 49-57.

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